The first two lectures, on the solar system and on comets, are by the director of the Lick Observatory. Surely the time is at hand for an advance in our knowledge of the physics of comets. Dr. Aitken, who has acted as editor of the volume, is responsible for three lectures—on solar eclipses, on the moon, and on recent results from stars and nebulæ. Dr. H. D. Curtis discourses on nebulæ and on some aspects of astronomical discovery. Four single lectures are by Dr. Crawford on epochs in astronomical history, by Dr. St. John on the sun, by Dr. Leuschner on motions in the solar system, dealing mainly with recent computing work at Berkeley, and by Mr. Seares on the brightness, colours, distribution, and motions of the stars. These last three are very useful summaries of current work. The final lecture, on the Mount Wilson 100-in. reflector, was delivered by Dr. Ritchey, but not reduced to writing, and, owing to the lecturer's preoccupation with war work, it has been necessary to substitute an account compiled from other sources.

The book deserved an index. The photograph of the Pleiades (plate xliv.) was not by *Sir* Isaac Roberts. Did space not forbid, one would be tempted to dispute some of Dr. Crawford's views of history. Both he and Dr. Leuschner disparage Kepler's achievements by calling them guesswork. If to be fertile in hypotheses and to submit them instantly to the test of comparison with good observations be guesswork, then a good part of the truest scientific method is guesswork. Of this part Kepler is the supreme and unrivalled example.

(2) A reviewer would be quite justified in declining to take Mr. Black's little book seriously. It is a dreary collection of petty calculations, made with 7-figure logarithms when 4-figure would have been ample and printed *in extenso*. As there is no clear and intelligible summary, it takes no little trouble to find out what is the precise object aimed at, or how successfully that object is attained. But the effect is to set up an empirical relation between the rotation periods of the planets and their masses and radii, which may be expressed by the formula (p. 56)

$$\frac{T_1}{T_2}=\left(\frac{R_2}{R_1}\right)^{\frac{1}{2}}\left(\frac{g_1}{g_2}\right)^{\frac{1}{3}}=\left(\frac{M_1}{M_2}\right)^{\frac{1}{3}}\left(\frac{R_2}{R_1}\right)^{\frac{7}{6}},$$

$g=M/R^2$ being the surface gravity; the corresponding suffix notation is not Mr. Black's. Now among the eight planets the rotation periods of four are practically unknown. Obviously, three assumed periods can be satisfied rigorously by a proper choice of the two exponents. Hence a consistent result for the Earth, Mars, and Jupiter, with a 20 per cent. error for Saturn, has nothing impressive about it. The author then goes on to complicate his formula further by introducing imaginary satellites skimming over the surface of imaginary planets, and the effect (p. 59) can be expressed in the form

$$\frac{T_1}{T_2}=\left(\frac{R_2}{R_1}\right)^{\frac{3}{2}}\left(\frac{M_1}{M_2}\right)^{\frac{1}{3}}\left(\frac{M_2R_1^3}{M_1R_2^3}\right)^{\frac{1}{18}}\left(\frac{M_1R_1^3}{M_2R_2^3}\right)^{\frac{1}{18}}=\left(\frac{M_1}{M_2}\right)^{\frac{1}{3}}\left(\frac{R_2}{R_1}\right)^{\frac{7}{6}}.$$

So the results are naturally the same. In fact, Mr. Black plays on himself a variant of the old game beginning "Think of a number" with a portentous elaboration which may amuse some readers. On p. 59 the Sun should be substituted for the first planet mentioned in the definitions of both M and *m*.

The foundation of a second essay rests on the approximate equality of the mass ratios

$$\frac{\text{Jupiter}}{\text{Mars}}=\frac{\text{Saturn}}{\text{Mercury}},\quad \frac{\text{Uranus}}{\text{Venus}}=\frac{\text{Neptune}}{\text{Earth}}.$$

Of course, the mass of Mercury is really unknown, but it is rather remarkable that Newcomb's masses for Uranus and Neptune only require an adjustment each within 2 per cent. to make the second relation exact. With this slender material the author again builds up elaborate arithmetical combinations and finds an evident delight in results which are nothing more than simple numerical verifications of the laws of proportion.

H. C. P.

THE DOMINION OF MAN.

The Outline of History: Being a Plain History of Life and Mankind. By H. G. Wells. With the editorial help of Mr. Ernest Barker, Sir H. H. Johnston, Sir E. Ray Lankester, and Prof. Gilbert Murray. To be completed in about twenty fortnightly parts. Part i. Pp. 32. (London: George Newnes, Ltd.) Price 1*s.* 2*d.* net.

IN this first part of his "Outline of History" Mr. H. G. Wells has surpassed the old author who carried the Trojan war back to Leda's eggs, for he begins with our solar system as a nebula condensing into sun and planets, and our earth as a mass of glowing matter. He tells how, in the course of cooling, an ocean gathered on its surface, on the margin of which the first structureless organic matter at last appeared, from which, in the course of ages, the earth's living tenants were developed. He describes in graphic terms not a few characteristic members in their succession, some of which are well depicted by Mr. J. F. Horrabin. Once or twice a phrase occurs to which we may demur: for instance, the nautilus is not a genus of ammonite; volcanic eruptions are more often a consequence than a cause of mountain upheaval; and we doubt whether the changes between the Mesozoic and the Kainozoic were so "catastrophic" as he implies. But these are trifles, and we find, after a discussion of the estimates of geological time, a good sketch of natural selection and the changes of species. As these changes in life depend not only on alterations in the world's physical geography, but also on its climate, the causes of the latter are briefly explained.

Next, Mr. Wells, after sketching the strange living tenants of the earth in ages when no creature with a backbone existed in sea or on land, brings before his readers the strange aspects of the earlier vertebrates, such as Pareiosaurus, which, low down as it is among the reptiles, seems as if striving to be a mammal. This leads

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to the "Age of Reptiles," which is illustrated by such huge forms as Brontosaurus and Diplodocus, Stegosaurus and Triceratops, which might be a first attempt at a Pachyderm, together with Megalosaurus, Tyrannosaurus, and Iguanodon, besides Plesiosaurus and Ichthyosaurus in the sea, with flying creatures like Pterodactyles and Archæopteryx, half bird, half lizard; and then dentigerous birds, which pass on to the Kainozoic, and end the present part of the work, which when completed will be a broad survey of the world throughout time.

Mr. Wells has undertaken a difficult task, and it is not too much to say that no other writer of the present day is so well equipped as he is to bring it to a successful completion. He possesses the rare combination of brilliant literary power with comprehensive and precise knowledge, and this distinctive quality makes his work one in which all intelligent readers will find profit and delight.

OUR BOOKSHELF.

Principles of Electric Spark Ignition in Internal-combustion Engines. By J. D. Morgan. Pp. vii+88. (London: Crosby Lockwood and Son, 1920.) Price 8*s*. 6*d*. net.

IN the eighty or so pages of this little book Mr. Morgan gives the result of certain experiments by others and himself to determine the nature of electric spark ignition in internal-combustion engines. A wide circle of readers will feel grateful to the author for providing in this convenient form an account of the more important work along these lines, and for the reference which he provides to the sources from which information in fuller detail may be obtained. Mr. Morgan puts them still further in his debt by the lucidity with which he writes, and his manifest endeavour—almost always successful—to ensure that, even in the more intricate parts of the subject, his phraseology shall be free from the ambiguity which is so often the despair of readers of technical books.

Mr. Morgan explains most ingeniously and simply his view of the double nature of the spark, its important "capacity" component and the less valuable "inductance" oscillation. Experiment so far has failed to show any effect on the resultant gaseous explosion, or on the upper and lower limits of richness at which explosion will occur, of change in the size, temperature, energy, or other feature of the spark. Any one individual spark seems to be as good as any other, provided that explosion is caused; but the apparatus must be unfailing in the succession of sparks which it is designed to provide.

The book is one which should be in the hands of all who are interested in the scientific side of the design of internal-combustion engines in their many forms. That further work along these lines will cause spark gaps to be less sensitive than they now are to short circuiting caused by the inevitable gradual loss of insulation is greatly to be hoped.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Gravitation and Light.

JUPITER ought just to show the Einstein deflection, for if it pass between two stars a couple of diameters of the planet apart, their temporary relative displacement will be a "third" of arc, the sixtieth of a second; and this could be measured with a heliometer.

OLIVER J. LODGE.

Mariemont, Edgbaston, December 6.

The Deflection of Light during a Solar Eclipse.

PROF. ANDERSON suggested in NATURE of December 4 (p. 354) a possible source of systematic error in the determination of the deflection of light at an eclipse, owing to lateral refraction caused by a temperature-gradient in the shadow-cone in our atmosphere. Having carefully considered this suggestion, I feel convinced that the effects of any possible temperature-gradient would be small.

Taking the height of the atmosphere as 10 miles, the ray from a star 30′ from the sun's centre would traverse a distance of 150 yards in the direction perpendicular to the shadow-axis whilst passing through our atmosphere. Prof. Anderson estimates a temperature-drop of 1/18 of a degree as required to produce the observed deflection. Thus the lateral temperature-gradient must be 1° C. per 1½ miles. The shadow moves over the earth at about 30 miles a minute, so that for a stationary observer the fall of temperature would have to be at the rate of 20° a minute to produce the observed effect.

In the case of a single surface of discontinuity, considered for simplicity by Prof. Anderson, the displacement by lateral refraction is inversely proportional to the distance from the sun's centre; but this law does not apply in the actual case of a continuous temperature-gradient.

It seems possible that the effect might amount to as much as 1/20 of the Einstein deflection in some cases, and possibly the rather high value found at Sobral has been increased by this cause. At Principe there was no perceptible change of temperature during the eclipse, but the climatic conditions there are exceptional.

A. S. EDDINGTON.

Observatory, Cambridge.

PROF. ANDERSON'S letter in NATURE of December 4 raises a point well worthy of consideration—that is, the possibility of abnormal refraction due to the lowering of temperature in the air by the passage of the shadow cone. I do not, however, think that more than a very small portion of the effect noted at Sobral could be explained in this way. The shadow ellipse was 194 miles long (direction of motion) and 137 miles broad. I have drawn a section in the former direction to scale, taking the height as 20 miles. It is certainly unnecessary to take it higher, as the temperature of the upper air is unaffected by the passage of the shadow.

Photographs were taken at Sobral at uniform intervals throughout totality, and all give tolerably accordant values of the shift.

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